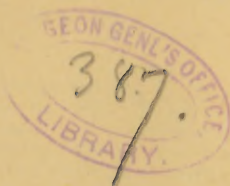


WILBER (F. A.)

Water-Supply from wells,
in its relation to health.



Wilber (F. A.)

WATER-SUPPLY FROM WELLS, IN ITS RELATION TO HEALTH.

BY FRANCIS A. WILBER, M.S.,

Adjunct Professor of Analytical Chemistry, Rutgers College.

[Reprinted from the *Proceedings of the New Jersey State Board of Health, for the year 1888.*]

In considering this subject, let us notice :

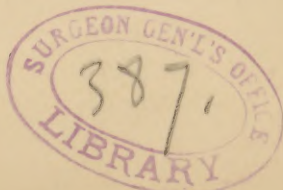
1. The source of supply of well water ; 2. Its collection ; 3. The sources of its impurities ; 4. Nature's means for removing such impurities, and the failure of these means ; 5. The relation between these impurities and public health.

The earth's surface is receiving, at frequent intervals, moisture from rainfall. A large portion of this fall is vaporized, and returned to the atmosphere directly, to be again condensed and re-precipitated as rain. A larger portion penetrates the porous soil, percolating through it, and seeking lower levels, striving to return to the water-courses or natural drains. This portion follows the more porous strata of the soil, and finds its way into all subterranean openings. As the numerous minute underground streams flow on, they unite, just as above ground, and form hidden water-courses, whose distance from the surface depends upon the stratification of the soil and rock. The water of these streams holds in solution all those soluble mineral and organic constituents of the soil with which it has come in contact for a time sufficiently long to dissolve them.

Into these covered streams are constantly percolating the drainage-waters from the soil directly above them. If this soil is porous, and the elevation considerable, the surface drainage penetrates long distances. If the porous stratum that carries the original stream passes under an impervious stratum of clay or rock, these surface additions may cease, and the stream flow on unaffected by the drainage from the soil above it.

The householder, needing water, sinks a shaft through the surface strata until he meets one of these underground streams, or water-saturated strata, and the water, finding in this shaft an underground reservoir, either flows rapidly or leaches more slowly in until a supply sufficient for his needs is collected. The shaft may be a deep one, passing through hundreds of feet of soil and rock, until it reaches the underground stream or reservoir. When this is reached, the head forces the water towards the surface, and we call the shaft an artesian well ; or the excavation may be only a few feet in depth, when, the saturated layer being reached, the incoming water supplies the needs of the owner of the soil. This is the ordinary well in which hangs "the old oaken bucket."

I have hastily mentioned the source and method of collection of underground water in order to make more clear what I have to say regarding the use of well-waters in the country, or in more thickly-settled regions. I am well aware that these facts are very common ones and that they may be well known to all, but it is to be feared that all sanitary workers do not, at all times, bear



them in mind when speaking or writing on questions of water-supply. The only source of supply is the water descending as rain, and the only way in which it reaches the place from which it is taken for the household use is this drainage through the soil.

The water in a well may receive impurities in several ways. The construction of the well may be faulty, so that surface drainage is allowed to flow into the well over its top, or, sinking into the surface soil, force its way through the wall. Or the situation of the well may be such that, while it is free from danger from the immediate vicinity, so far as surface drainage is concerned, it still receives surface-water from sources of filth more remote. This drainage may flow in, in a practically unchanged condition, or it may be altered, as mentioned later.

The condition in which this filth reaches the well depends upon the distance that it flows to reach it, the time consumed in the flow and the character of the soil flowed through.

The average house-owner certainly believes that the water which he pumps clear and cool from his well is pure and wholesome. He does not stop to think of the impurities with which it may have come in contact during its flow from the surface to the bottom of his well. This well may be sunk in the immediate vicinity of an overflowing cesspool or out-house; the natural drainage of his own or his neighbor's barn-yard or pig-sty may be flowing over the soil, through which is filtering the water that is to fill this underground cistern; or its bottom may be in a porous stratum of soil or gravel that receives, at a point higher than the bottom, the drainage from some grave-yard or other source of decaying organic matter; some neighboring tree may have thrust its rootlets through the wall of the well and there they remain to decay, or the top may not be tightly covered and stray toads or other vermin may tumble in to aid in the pollution of the supply, but our well-owner, not seeing, smelling or tasting the results of these additions to the underground reservoir, is not conscious of their existence. Nor is this indifference to the condition of the soil that serves as a filter for the household water-supply, or the surroundings of the well, confined to the ignorant man. Even the physician may, and in my experience not infrequently does, hold that impurities, mineral and organic, are removed from surface-water by the processes of natural filtration through the soil. If the soil was in a condition of virgin purity, and if the tax made on its filtering power was limited or only occasional, this might be the case. But such virgin condition of purity is not found in the natural filter-bed in thickly-settled or old localities. It is true that in passing through almost any soil-filter, turbid, filthy water loses its suspended matter and becomes clear. It is, therefore, commonly said to be filtered, the popular definition of filtration being the removal of such suspended matter. Filtration is this and much more. The water charged with organic and mineral salts and undecomposed organic matter in minute subdivision passes into the soil. If it has to flow any considerable distance the coarser suspended matter is held mechanically, as the water forces its way downward. At the same time the organic acids in solution act upon the oxides of iron and alumina in the soil, forming soluble compounds of these substances. These compounds, in turn, re-act upon the albuminous matter carried by the water, and coagulate it. The clots thus formed can no longer pass through the soil, from mechanical reasons, and they are consequently removed from the water. Together with these precipitated albuminous matters, and mechanically held by them, goes much of the suspended mineral matter, and a chemical purification of the water has been effected. This, in brief, is true filtration by nature's process.

Now, let the flow of organic impurities through this natural filter-bed be so great as to fill it with this precipitated organic matter. Decomposition of the masses of organic filth thus carried into the soil, takes place, and the soluble products of this decomposition flow on with the underground streams until a well offers a collecting-place for them. Nor is this all. The soil, being taxed by the large amount of impurities sent through it beyond its filtering power, allows these soluble products to pass unchanged, and they are carried directly into the well, where the cessation of flow allows them to accumulate. Such a

filth-saturated condition of the soil exists in every old thickly-settled community. Here every stable, every out-house or cesspool, with their porous-walled (if walled at all) vaults, every kitchen drain and sewer, is furnishing its quota of organic impurities, all of which supply matter for decomposition.

The products of this decomposition are carried, as we have seen, directly to the wells, and they thus become suitable breeding-places for bacterial life—powder magazines—only needing the spark of a typhoid or other deadly germ to furnish the explosion of a scourge of disease. This filth-saturated condition of the soil is no flight of fancy, but solid fact, as every one who has watched the digging of a sewer or other excavation in a town, well knows. In a stiff, impervious soil the collection of organic filth is enormous, and the dangerous character of the organic matter in such soil when it is disturbed, is well known to every physician. Outbreaks of malarial disorders are almost certain to follow such disturbance. Nor are the conditions as to safety greater in a town built upon a sandy or porous soil. Here the organic impurities do not collect in such quantities in the soil, but to offset that, the flow from the surface to the water line of the well is more rapid. The well-owner, in this case, can drink, to-morrow, the kitchen slops or more nauseous wastes emptied yesterday upon the sand near his well. In districts underlaid by rocky strata, the danger does not disappear, as the seams in the rock, or faults in stratification, furnish convenient inlets for surface filth. This filth-polluted water, collected from either rocky strata, porous or compact soils, does not always (perhaps we might say does not usually) advertise its dangerous character. It is apt to be clear and cool, and is sought after for household use. There are no visible signs to show its condition, and the well-owner is usually prompt to resent as a personal grievance, any suggestion that the water is unfit for use. Striking instances of this could be given, but I will mention only one or two.

In New Brunswick, a well known to have been in use for more than 100 years, was located directly in the rear of a tenement-house and its surrounding out-houses. This house was used for many years as a tavern, the slops from the kitchen being discharged in the immediate vicinity. Near by was an old stable-yard and stables, the surface drainage from both being directly towards the well. The soil in the entire vicinity was completely saturated with organic impurities, and although the supply that fed the well did not come from surface or local drainage, it was supplemented by both. The water from this well was clear, cold and agreeable to the taste, and was much sought after for drinking purposes. Chemical and bacteriological tests showed it to be the merest sewage, and yet when the facts were stated, many persons using the well were greatly offended at the *attack* upon the character of this water.

Another case was that of a well situated in a depression in the red shale that had become filled with sand. The water was used by numerous families, and during the summer there was scarcely ever a time when some one in this vicinity was not suffering from low fevers or bowel troubles. The quality of the water was shown, and the well closed by the Board of Health, and great was the cry at the *injustice* inflicted upon this locality.

The popular indifference to the condition of the soil surrounding the household water-supply is very great.

Men who would not for an instant allow the presence of filth in connection with the bread or meat put on their tables, will not give a moment's thought to the state of the filter-bed through which passes the water daily used by their families. Worse than that, they will deliberately make large additions of household filth to the surface of this filter-bed.

It is my province to set forth the full effects of the use of water thus filth-saturated, upon the public health. The condition of the soil in the country, village and town is, in many cases, such that such water, only, can be obtained from the wells sunk in it. The physician can tell you that, while water containing organic impurities may not be a direct producer of disease, it still can work its evil by inducing a gradual lowering of the tone of the system. Persons using such water are less able to withstand the assaults of prevailing diseases. This is particularly the case when this water is used by small children and aged and infirm persons. I firmly believe that a large proportion of the

deaths of infants, during the heated term of our summers, is directly induced by the use of just such water, and in many cases coming under my own observation this belief has been directly confirmed.

Add, now, to the direct results of the use of filthy well-waters the indirect danger that they furnish in providing breeding-places for disease germs, and the most convenient means for distributing such germs and introducing them into the systems of those using them, and you have an indictment sufficiently strong to insure conviction unless the grounds taken here can be disproved.

Health authorities, everywhere, recognize, to some extent, the dangers to public health arising from the use of well-waters in towns and cities. The labors of such officers would be greatly lessened if it were possible to convince the communities using wells as sources of household water-supply, of the dangers to which they are being subjected. Ignorance lies at the bottom of public indifference to this and similar sanitary matters, and only persistent and wise pressure on the part of those interested in sanitary progress will lead to a removal of this ignorance.

The study of hygiene in the public schools will prepare the public mind for more intelligent thinking on such subjects, and judicious agitation can be made to do its part in this important work.

There are but few towns in our State in which water-supply from wells is at all admissible. In one or two instances, the geological structure underlying a town renders a present use of wells possible. In these cases, a stiff clay, impervious to water, overlies the gravel strata that carries the water. This gravel formation outcrops and receives its drainage-water, entirely outside the town, in a hilly, scantily-settled region. The water flowing underneath the town is, therefore, not polluted by surface drainage, and is fit for use. It will continue to be fit until there are a sufficient number of avenues for the passage of surface-water through the clay made to allow it to become polluted.

In concluding this brief sketch of the dangers to public health arising from the use of water obtained from wells in towns and cities, let me call attention to the great value of pure water as a remedial agent. We know very little of its effects, as the use of water containing mineral or organic constituents, or both, in considerable quantities, is almost universal. Absolutely pure water is one of the greatest luxuries of modern life, and nothing, in our modern civilization, marks more strongly public enlightenment in matters of health than does the interest now being taken in the subject of water-supply for towns and cities.

